

## Resistance Training and Injury Prevention

The benefits of resistance training in both competitive and recreational athletes have been well documented over the past 20 years. Improvements in muscle strength and power, increase in muscle size, and improvement in sports performance are common benefits resulting from resistance training programs. In addition, resistance training has also been suggested to reduce the risk for musculoskeletal injuries, or perhaps reduce the severity of such injury. Although studies reporting the direct effect of resistance training on injury rate reduction are limited, the physiological adaptations seen consequent to resistance training on bone, connective tissue and muscle does imply enhanced protection against injury for individuals who participate in such a training program.

### Effect on Bone

Because bone is living tissue, it has the ability to remodel and adapt to the physical stresses imposed on it. Individuals who are physically active have been shown to have greater bone mineral density than sedentary individuals. In general, physically active persons are at a reduced risk for osteoporosis, fracture or other ailments related to bone deterioration. Although bone will respond to many types of training programs, especially those with high strain such as jumping or running, it does appear that resistance training provides the greatest osteogenic (increase in bone mineral density) effect. Resistance training is beneficial for increasing bone strength, and muscular strength also appears to be positively related to bone mineral content and bone strength. As lower-body strength levels increase, the incidence of stress fracture is reduced. Thus muscular strength improves bone strength as well. However, it is not clear whether the relative improvements in bone and muscle strength during a resistance training program are similar.

### Effect on Connective Tissue

Connective tissue provides the support or framework of the body. It consists of cells and fibers imbedded in a gel-like material containing tissue fluids and various metabolites. The primary fiber of connective tissue is collagen. Although to date there has been little research conducted on the direct effect of resistance training on connective tissue adaptations, what studies there are have reported increases in both the size and strength of ligaments and tendons. Increases in the size of connective tissues are thought to be the result of an increase in the collagen content within the connective tissue sheaths. Although collagen content increases with training, comparisons between untrained individuals and body builders suggest that the increase in collagen content is proportional to the increase in muscle. Body builders seem to have greater absolute collagen content, but relative values are similar to untrained controls. Thus, increases in muscle mass are likely met by increases in the size and strength of the connective tissue.

### Effect on Muscle

Decreases in muscle mass (sarcopenia) and subsequent reductions in muscle strength as one ages not only results in a loss of functional ability, but also increases the risk for falls and fractures. Resistance training programs for an aging population have the same benefits for increase in both strength and muscle size as such programs do for the younger and more active population. As functional ability is maintained or improved, the risk for injury is significantly reduced. Resistance training also has an important role in reducing the risk for musculoskeletal injuries related to muscle imbalance, expressed as either an agonist to antagonist ratio (i.e., knee flexors/knee extensors) or as a bilateral comparison (i.e., right and left knee flexors). Correction of the existing imbalance through a resistance training program is important to reducing the individual's risk for muscle injury.

Resistance training programs also have a positive effect on reducing low back injuries. Whether this reduced risk is related to increased strength in the lumbar extensors or to stronger lumbar vertebrae is not known. However, the benefits of resistance training on reducing back injuries and associated expenses are well acknowledged.



Reducing the incidence of injury by engaging in a resistance training program is as beneficial for the noncompetitive beginner as it is for the professional athlete. The most important step, after medical clearance, is to locate a qualified individual (exercise scientist/physiologist or sport trainer) to develop a safe and effective resistance training program.

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